

Preliminary Classification:

Proposed Class:

Subclass:

NOTE: "All applicants are requested to include a preliminary classification on newly filed patent applications. The preliminary classification, preferably class and subclass designations, should be identified in the upper right-hand corner of the letter of transmittal accompanying the application papers, for example 'Proposed Class 2, subclass 129.'" M.P.E.P. § 601, 7th ed.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Box Patent Application
Assistant Commissioner for Patents
Washington, D.C. 20231

NEW APPLICATION TRANSMITTAL

Transmitted herewith for filing is the patent application of

Inventor(s): Nikolai NEFEDOV

WARNING: 37 C.F.R. § 1.41(a)(1) points out:

"(a) A patent is applied for in the name or names of the actual inventor or inventors.

"(1) The inventorship of a nonprovisional application is that inventorship set forth in the oath or declaration as prescribed by § 1.63, except as provided for in § 1.53(d)(4) and § 1.63(d). If an oath or declaration as prescribed by § 1.63 is not filed during the pendency of a nonprovisional application, the inventorship is that inventorship set forth in the application papers filed pursuant to § 1.53(b), unless a petition under this paragraph accompanied by the fee set forth in § 1.17(f) is filed supplying or changing the name or names of the inventor or inventors."

For (title): METHOD AND APPARATUS FOR CHANNEL CODING AND DECODING FOR MODULATION
SCHEMES WITH MEMORY

CERTIFICATION UNDER 37 C.F.R. § 1.10*

(Express Mail label number is mandatory.)

(Express Mail certification is optional.)

I hereby certify that this New Application Transmittal and the documents referred to as attached therein are being deposited with the United States Postal Service on this date August 11, 1999, in an envelope as "Express Mail Post Office to Addressee," mailing Label Number EL336859704US, addressed to the: Assistant Commissioner for Patents, Washington, D.C. 20231.

Maureen Egan

(type or print name of person mailing paper)

Signature of person mailing paper

WARNING: Certificate of mailing (first class) or facsimile transmission procedures of 37 C.F.R. § 1.8 cannot be used to obtain a date of mailing or transmission for this correspondence.

***WARNING:** Each paper or fee filed by "Express Mail" must have the number of the "Express Mail" mailing label placed thereon prior to mailing. 37 C.F.R. § 1.10(b).

"Since the filing of correspondence under § 1.10 without the Express Mail mailing label thereon is an oversight that can be avoided by the exercise of reasonable care, requests for waiver of this requirement will **not** be granted on petition." Notice of Oct. 24, 1996, 60 Fed. Reg. 56,439, at 56,442.

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1. Type of Application

This new application is for a(n)

(check one applicable item below)

- ☒ Original (nonprovisional)
- ☐ Design
- ☐ Plant

WARNING: Do not use this transmittal for a completion in the U.S. of an International Application under 35 U.S.C. § 371(c)(4), unless the International Application is being filed as a divisional, continuation or continuation-in-part application.

WARNING: Do not use this transmittal for the filing of a provisional application.

NOTE: If one of the following 3 items apply, then complete and attach ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF A PRIOR U.S. APPLICATION CLAIMED and a NOTIFICATION IN PARENT APPLICATION OF THE FILING OF THIS CONTINUATION APPLICATION.

- ☐ Divisional.
- ☐ Continuation.
- ☐ Continuation-in-part (C-I-P).

2. Benefit of Prior U.S. Application(s) (35 U.S.C. §§ 119(e), 120, or 121)

NOTE: A nonprovisional application may claim an invention disclosed in one or more prior filed copending nonprovisional applications or copending international applications designating the United States of America. In order for a nonprovisional application to claim the benefit of a prior filed copending nonprovisional application or copending international application designating the United States of America, each prior application must name as an inventor at least one inventor named in the later filed nonprovisional application and disclose the named inventor's invention claimed in at least one claim of the later filed nonprovisional application in the manner provided by the first paragraph of 35 U.S.C. § 112. Each prior application must also be:

- (i) An international application entitled to a filing date in accordance with PCT Article 11 and designating the United States of America; or
- (ii) Complete as set forth in § 1.51(b); or
- (iii) Entitled to a filing date as set forth in § 1.53(b) or § 1.53(d) and include the basic filing fee set forth in § 1.16; or
- (iv) Entitled to a filing date as set forth in § 1.53(b) and have paid therein the processing and retention fee set forth in § 1.21(f) within the time period set forth in § 1.53(f).

37 C.F.R. § 1.78(a)(1).

NOTE: If the new application being transmitted is a divisional, continuation or a continuation-in-part of a parent case, or where the parent case is an International Application which designated the U.S., or benefit of a prior provisional application is claimed, then check the following item and complete and attach ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED.

WARNING: If an application claims the benefit of the filing date of an earlier filed application under 35 U.S.C. §§ 120, 121 or 365(c), the 20-year term of that application will be based upon the filing date of the earliest U.S. application that the application makes reference to under 35 U.S.C. §§ 120, 121 or 365(c). (35 U.S.C. § 154(a)(2) does not take into account, for the determination of the patent term, any application on which priority is claimed under 35 U.S.C. §§ 119, 365(a) or 365(b).) For a c-i-p application, applicant should review whether any claim in the patent that will issue is supported by an earlier application and, if not, the applicant should consider canceling the reference to the earlier filed application. The term of a patent is not based on a claim-by-claim approach. See Notice of April 14, 1995, 60 Fed. Reg. 20,195, at 20,205.

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WARNING: When the last day of pendency of a provisional application falls on a Saturday, Sunday, or Federal holiday within the District of Columbia, any nonprovisional application claiming benefit of the provisional application must be filed prior to the Saturday, Sunday, or Federal holiday within the District of Columbia. See 37 C.F.R. § 1.78(a)(3).

- ☐ The new application being transmitted claims the benefit of prior U.S. application(s). Enclosed are ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED.

3. Papers Enclosed

- A. Required for filing date under 37 C.F.R. § 1.53(b) (Regular) or 37 C.F.R. § 1.153 (Design) Application

10 Pages of specification

3 Pages of claims

2 Sheets of drawing

WARNING: DO NOT submit original drawings. A high quality copy of the drawings should be supplied when filing a patent application. The drawings that are submitted to the Office must be on strong, white, smooth, and non-shiny paper and meet the standards according to § 1.84. If corrections to the drawings are necessary, they should be made to the original drawing and a high-quality copy of the corrected original drawing then submitted to the Office. Only one copy is required or desired. For comments on proposed then-new 37 C.F.R. § 1.84, see Notice of March 9, 1988 (1990 O.G. 57-62).

NOTE: "Identifying indicia, if provided, should include the application number or the title of the invention, inventor's name, docket number (if any), and the name and telephone number of a person to call if the Office is unable to match the drawings to the proper application. This information should be placed on the back of each sheet of drawing a minimum distance of 1.5 cm. (5/8 inch) down from the top of the page . . ." 37 C.F.R. § 1.84(c).

(complete the following, if applicable)

- ☐ The enclosed drawing(s) are photograph(s), and there is also attached a "PETITION TO ACCEPT PHOTOGRAPH(S) AS DRAWING(S)." 37 C.F.R. § 1.84(b).

☐ formal

☐ informal

B. Other Papers Enclosed

6 Pages of declaration and power of attorney

1 Pages of abstract

 Other

4. Additional papers enclosed

- ☐ Amendment to claims

☐ Cancel in this applications claims _____ before calculating the filing fee. (At least one original independent claim must be retained for filing purposes.)

☐ Add the claims shown on the attached amendment. (Claims added have been numbered consecutively following the highest numbered original claims.)

☐ Preliminary Amendment

☒ Information Disclosure Statement (37 C.F.R. § 1.98)

☒ Form PTO-1449 (PTO/SB/08A and 08B)

☒ Citations

- ☐ Declaration of Biological Deposit
- ☐ Submission of "Sequence Listing," computer readable copy and/or amendment pertaining thereto for biotechnology invention containing nucleotide and/or amino acid sequence.
- ☐ Authorization of Attorney(s) to Accept and Follow Instructions from Representative
- ☐ Special Comments
- ☐ Other

5. Declaration or oath (including power of attorney)

NOTE: A newly executed declaration is not required in a continuation or divisional application provided that the prior nonprovisional application contained a declaration as required, the application being filed is by all or fewer than all the inventors named in the prior application, there is no new matter in the application being filed, and a copy of the executed declaration filed in the prior application (showing the signature or an indication thereon that it was signed) is submitted. The copy must be accompanied by a statement requesting deletion of the names of person(s) who are not inventors of the application being filed. If the declaration in the prior application was filed under § 1.47, then a copy of that declaration must be filed accompanied by a copy of the decision granting § 1.47 status or, if a nonsigning person under § 1.47 has subsequently joined in a prior application, then a copy of the subsequently executed declaration must be filed. See 37 C.F.R. §§ 1.63(d)(1)-(3).

NOTE: A declaration filed to complete an application must be executed, identify the specification to which it is directed, identify each inventor by full name including family name and at least one given name, without abbreviation together with any other given name or initial, and the residence, post office address and country or citizenship of each inventor, and state whether the inventor is a sole or joint inventor. 37 C.F.R. § 1.63(a)(1)-(4).

☒ Enclosed

Executed by

(check all applicable boxes)

☒ inventor(s).

☐ legal representative of inventor(s).

37 C.F.R. §§ 1.42 or 1.43.

☐ joint inventor or person showing a proprietary interest on behalf of inventor who refused to sign or cannot be reached.

☐ This is the petition required by 37 C.F.R. § 1.47 and the statement required by 37 C.F.R. § 1.47 is also attached. See item 13 below for fee.

☐ Not Enclosed.

NOTE: Where the filing is a completion in the U.S. of an International Application or where the completion of the U.S. application contains subject matter in addition to the International Application, the application may be treated as a continuation or continuation-in-part, as the case may be, utilizing ADDED PAGE FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION CLAIMED.

☐ Application is made by a person authorized under 37 C.F.R. § 1.41(c) on behalf of all the above named inventor(s).

(The declaration or oath, along with the surcharge required by 37 C.F.R. § 1.16(e) can be filed subsequently).

☐ Showing that the filing is authorized.
(not required unless called into question. 37 C.F.R. § 1.41(d))

6. Inventorship Statement

WARNING: If the named inventors are each not the inventors of all the claims an explanation, including the ownership of the various claims at the time the last claimed invention was made, should be submitted.

The inventorship for all the claims in this application are:

☐ The same.

or

☐ Not the same. An explanation, including the ownership of the various claims at the time the last claimed invention was made,

☐ is submitted.

☐ will be submitted.

7. Language

NOTE: An application including a signed oath or declaration may be filed in a language other than English. An English translation of the non-English language application and the processing fee of \$130.00 required by 37 C.F.R. § 1.17(k) is required to be filed with the application, or within such time as may be set by the Office, 37 C.F.R. § 1.52(d).

☒ English

☐ Non-English

☐ The attached translation includes a statement that the translation is accurate. 37 C.F.R. § 1.52(d).

8. Assignment

☒ An assignment of the invention to Nokia Mobile Phones Limited

☐ is attached. A separate ☐ "COVER SHEET FOR ASSIGNMENT (DOCUMENT) ACCOMPANYING NEW PATENT APPLICATION" or ☐ FORM PTO 1595 is also attached.

☒ will follow.

NOTE: "If an assignment is submitted with a new application, send two separate letters—one for the application and one for the assignment." Notice of May 4, 1990 (1114 O.G. 77-78).

WARNING: A newly executed "CERTIFICATE UNDER 37 C.F.R. § 3.73(b)" must be filed when a continuation-in-part application is filed by an assignee. Notice of April 30, 1993, 1150 O.G. 62-64.

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9. Certified Copy

Certified copy(ies) of application(s)

Country	Appln. No.	Filed
Finland	981745	August 12, 1998
Country	Appln. No.	Filed
Country	Appln. No.	Filed

from which priority is claimed

☒ Is (are) attached.☐ will follow.

NOTE: The foreign application forming the basis for the claim for priority must be referred to in the oath or declaration. 37 C.F.R. § 1.55(a) and 1.63.

NOTE: This item is for any foreign priority for which the application being filed directly relates. If any parent U.S. application or International Application from which this application claims benefit under 35 U.S.C. § 120 is itself entitled to priority from a prior foreign application, then complete item 18 on the ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED.

10. Fee Calculation (37 C.F.R. § 1.16)A. ☒ Regular application

CLAIMS AS FILED			
Number filed	Number Extra	Rate	Basic Fee 37 C.F.R. § 1.16(a) \$760.00
Total			
Claims (37 C.F.R. § 1.16(c))	14 - 20 = 0	×	\$ 18.00
Independent			
Claims (37 C.F.R. § 1.16(b))	3 - 3 = 0	×	\$ 78.00
Multiple dependent claim(s),			
If any (37 C.F.R. § 1.16(d))		+	\$260.00

☐ Amendment cancelling extra claims is enclosed.☐ Amendment deleting multiple-dependencies is enclosed.☐ Fee for extra claims is not being paid at this time.

NOTE: If the fees for extra claims are not paid on filing they must be paid or the claims cancelled by amendment, prior to the expiration of the time period set for response by the Patent and Trademark Office in any notice of fee deficiency. 37 C.F.R. § 1.16(d).

Filing Fee Calculation

\$760.00

B. ☐ Design application

(\$310.00—37 C.F.R. § 1.16(f))

Filing Fee Calculation

\$

C. ☐ Plant application

(\$480.00—37 C.F.R. § 1.16(g))

Filing fee calculation

\$

11. Small Entity Statement(s)

- ☐ Statement(s) that this is a filing by a small entity under 37 C.F.R. § 1.9 and 1.27 is (are) attached.

WARNING: "Status as a small entity must be specifically established in each application or patent in which the status is available and desired. Status as a small entity in one application or patent does not affect any other application or patent, including applications or patents which are directly or indirectly dependent upon the application or patent in which the status has been established. The refiling of an application under § 1.53 as a continuation, division, or continuation-in-part (including a continued prosecution application under § 1.53(d)), or the filing of a reissue application requires a new determination as to continued entitlement to small entity status for the continuing or reissue application. A nonprovisional application claiming benefit under 35 U.S.C. § 119(e), 120, 121, or 365(c) of a prior application, or a reissue application may rely on a statement filed in the prior application or in the patent if the nonprovisional application or the reissue application includes a reference to the statement in the prior application or in the patent or includes a copy of the statement in the prior application or in the patent and status as a small entity is still proper and desired. The payment of the small entity basic statutory filing fee will be treated as such a reference for purposes of this section." 37 C.F.R. § 1.28(a)(2).

WARNING: "Small entity status must not be established when the person or persons signing the . . . statement can unequivocally make the required self-certification." M.P.E.P., § 509.03, 6th ed., rev. 2, July 1996 (emphasis added).

(complete the following, if applicable)

- ☐ Status as a small entity was claimed in prior application
_____/_____, filed on _____, from which benefit
is being claimed for this application under:

35 U.S.C. § ☐ 119(e),
☐ 120,
☐ 121,
☐ 365(c),

and which status as a small entity is still proper and desired.

- ☐ A copy of the statement in the prior application is included.

Filing Fee Calculation (50% of A, B or C above)

\$ _____

NOTE: Any excess of the full fee paid will be refunded if small entity status is established and a refund request are filed within 2 months of the date of timely payment of a full fee. The two-month period is not extendable under § 1.136. 37 C.F.R. § 1.28(a).

12. Request for International-Type Search (37 C.F.R. § 1.104(d))

(complete, if applicable)

- ☐ Please prepare an international-type search report for this application at the time when national examination on the merits takes place.

13. Fee Payment Being Made at This Time

☐ Not Enclosed

☐ No filing fee is to be paid at this time.

(This and the surcharge required by 37 C.F.R. § 1.16(e) can be paid subsequently.)

☒ Enclosed

☒ Filing fee

\$ 760.00

☐ Recording assignment

(\$40.00; 37 C.F.R. § 1.21(h))

(See attached "COVER SHEET FOR
ASSIGNMENT ACCOMPANYING NEW
APPLICATION".)

\$ _____

☐ Petition fee for filing by other than all the
inventors or person on behalf of the inventor
where inventor refused to sign or cannot be
reached

(\$130.00; 37 C.F.R. §§ 1.47 and 1.17(l))

\$ _____

☐ For processing an application with a
specification in

a non-English language

(\$130.00; 37 C.F.R. §§ 1.52(d) and 1.17(k))

\$ _____

☐ Processing and retention fee

(\$130.00; 37 C.F.R. §§ 1.53(d) and 1.21(l))

\$ _____

☐ Fee for international-type search report

(\$40.00; 37 C.F.R. § 1.21(e))

\$ _____

NOTE: 37 C.F.R. § 1.21(f) establishes a fee for processing and retaining any application that is abandoned for failing to complete the application pursuant to 37 C.F.R. § 1.53(f) and this, as well as the changes to 37 C.F.R. §§ 1.53 and 1.78(a)(1), indicate that in order to obtain the benefit of a prior U.S. application, either the basic filing fee must be paid, or the processing and retention fee of § 1.21(f) must be paid, within 1 year from notification under § 53(f).

Total fees enclosed

\$ 760.00

14. Method of Payment of Fees

☒ Check in the amount of \$ 760.00

☐ Charge Account No. _____ in the amount of
\$ _____

A duplicate of this transmittal is attached.

NOTE: Fees should be itemized in such a manner that it is clear for which purpose the fees are paid. 37 C.F.R. § 1.22(b).

15. Authorization to Charge Additional Fees

WARNING: If no fees are to be paid on filing, the following items should not be completed.

WARNING: Accurately count claims, especially multiple dependent claims, to avoid unexpected high charges, if extra claim charges are authorized.

- ☒ The Commissioner is hereby authorized to charge the following additional fees by this paper and during the entire pendency of this application to Account No. 16-1350:

☒ 37 C.F.R. § 1.16(a), (f) or (g) (filing fees)

☒ 37 C.F.R. § 1.16(b), (c) and (d) (presentation of extra claims)

NOTE: Because additional fees for excess or multiple dependent claims not paid on filing or on later presentation must only be paid or these claims cancelled by amendment prior to the expiration of the time period set for response by the PTO in any notice of fee deficiency (37 C.F.R. § 1.16(d)), it might be best not to authorize the PTO to charge additional claim fees, except possibly when dealing with amendments after final action.

☒ 37 C.F.R. § 1.16(e) (surcharge for filing the basic filing fee and/or declaration on a date later than the filing date of the application)

☒ 37 C.F.R. § 1.17(a)(1)-(5) (extension fees pursuant to § 1.136(a)).

☐ 37 C.F.R. § 1.17 (application processing fees)

NOTE: ". . . A written request may be submitted in an application that is an authorization to treat any concurrent or future reply, requiring a petition for an extension of time under this paragraph for its timely submission, as incorporating a petition for extension of time for the appropriate length of time. An authorization to charge all required fees, fees under § 1.17, or all required extension of time fees will be treated as a constructive petition for an extension of time in any concurrent or future reply requiring a petition for an extension of time under this paragraph for its timely submission. Submission of the fee set forth in § 1.17(a) will also be treated as a constructive petition for an extension of time in any concurrent reply requiring a petition for an extension of time under this paragraph for its timely submission." 37 C.F.R. § 1.136(a)(3).

☐ 37 C.F.R. § 1.18 (issue fee at or before mailing of Notice of Allowance, pursuant to 37 C.F.R. § 1.311(b))

NOTE: Where an authorization to charge the issue fee to a deposit account has been filed before the mailing of a Notice of Allowance, the issue fee will be automatically charged to the deposit account at the time of mailing the notice of allowance. 37 C.F.R. § 1.311(b).

NOTE: 37 C.F.R. § 1.28(b) requires "Notification of any change in status resulting in loss of entitlement to small entity status must be filed in the application . . . prior to paying, or at the time of paying, . . . the issue fee. . . ." From the wording of 37 C.F.R. § 1.28(b), (a) notification of change of status must be made even if the fee is paid as "other than a small entity" and (b) no notification is required if the change is to another small entity.

16. Instructions as to Overpayment

NOTE: "... Amounts of twenty-five dollars or less will not be returned unless specifically requested within a reasonable time, nor will the payer be notified of such amounts; amounts over twenty-five dollars may be returned by check or, if requested, by credit to a deposit account." 37 C.F.R. § 1.26(a).

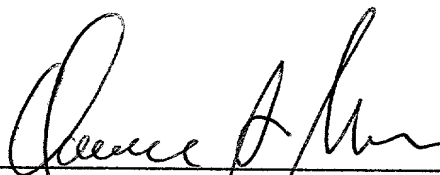
- ☒ Credit Account No. 16-1350
☐ Refund

SEND ALL CORRESPONDENCE TO:

Reg. No. 24,622

Tel. No. (203) 259-1800

Customer No.



SIGNATURE OF PRACTITIONER

Clarence A. Green

(type or print name of attorney)

PERMAN & GREEN, LLP

P.O. Address

425 Post Road, Fairfield, Connecticut 06430

☐ **Incorporation by reference of added pages**

(check the following item if the application in this transmittal claims the benefit of prior U.S. application(s) (including an international application entering the U.S. stage as a continuation, divisional or C-I-P application) and complete and attach the ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED)

- ☐ Plus Added Pages for New Application Transmittal Where Benefit of Prior U.S. Application(s) Claimed

Number of pages added _____

- ☐ Plus Added Pages for Papers Referred to in Item 4 Above

Number of pages added _____

- ☐ Plus added pages deleting names of inventor(s) named in prior application(s) who is/are no longer inventor(s) of the subject matter claimed in this application.

Number of pages added _____

- ☐ Plus "Assignment Cover Letter Accompanying New Application"

Number of pages added _____

☒ **Statement Where No Further Pages Added**

(if no further pages form a part of this Transmittal, then end this Transmittal with this page and check the following item)

- ☒ This transmittal ends with this page.

TITLE: Method and apparatus for channel coding and decoding for modulation schemes with memory

5 **TECHNOLOGICAL FIELD**

The invention concerns a method for channel coding and decoding that will provide good performance under a wide variety of radio channel conditions. The invention concerns also a transmitter device and a receiver device that will realize the method
10 of the invention in practice.

BACKGROUND OF THE INVENTION

15 Channel coding in general introduces redundancy into a flow of data to be transmitted. It increases the data rate in the transmitting device by adding into it information calculated from the contents of some consecutive blocks of data. After channel coding the data to be transmitted is in the form of consecutive code words. The reason for channel coding is to allow the detection or even the correction of
20 signal errors introduced later during transmission. The inverse operation of channel coding is channel decoding, which takes place in the receiving device. Channel coding is often accompanied by interleaving, in which bits of several code words are mixed together in a predetermined fashion. The aim of interleaving is to decorrelate errors that will potentially occur in the transmission so that the resulting erroneous
25 bits will be distributed into essentially randomised positions in several code words instead of corrupting a sequence of successive bits in a single code word. The inverse operation of interleaving is deinterleaving. Interleaving is sometimes assumed to form a single integrated functional entity together with pure channel coding.

30 As a background for the invention, the known full-rate speech channel coding and interleaving scheme of the GSM (Global System for Mobile telecommunications) digital cellular system is briefly described. The GSM channel encoder receives consecutive blocks of 260 bits from a speech encoder at a rate of 13 kbit/s, i.e. one
35 block at each 20 ms. Of the 260 bits of a block, the channel encoder protects 182 bits by a convolutional block code with a convolutional efficiency equal to $\frac{1}{2}$ and no puncturing. Among these 182 bits, 50 bits are additionally protected by a detection code that adds 3 redundancy bits. The other 78 bits go unprotected. The resulting

- code word is 456 bits long. In the interleaver it is split into eight groups of 57 bits. Each group will end up in a different transmission burst according to a specific diagonal interleaving scheme: the bits from positions $i, i+8, i+16, \dots, i+448$ go to the evenly numbered bit positions of a burst $N+i$, where N is the burst number referring to some burst numbering scheme and the index i determines the bit group and takes the integral values from 0 to 3. Similarly the bits from positions $j, j+8, j+16, \dots, j+448$ go to the oddly numbered bit positions of a burst $N+j$, where the index j takes the integral values from 4 to 7.
- 10 The performance of a channel coding and decoding scheme is measured as the simulated probability of undetected and/or uncorrected errors under different radio channel conditions. The conventional expression for the latter is E_b/N_0 or the amount of received bit energy over the combined noise and interference density. In a typical performance diagram a curve connects the points obtained as a result from
- 15 simulation in a semi-logarithmic scale where the horizontal axis is E_b/N_0 in decibels and the logarithmic vertical axis is BER (Bit Error Ratio) or other error ratio in negative powers of ten. The closer the curve is to the lower left point in the diagram, the better the performance. A coding-decoding scheme with good performance results is said to employ a powerful code.
- 20 Recently a class of very powerful binary "turbo" codes with efficient iterative decoding methods has been proposed in C. Berrou *et al.*: 'Near Shannon Limit Error-Correcting Coding and Decoding: Turbo Codes (1)', *Proc. ICC'93*, Geneva, pp.1064-1070, June 1993. A formal definition for the "turbo" codes is the Parallel
- 25 Concatenation of interleaved Convolutional Codes (PCCC). Despite of their good performance, the publications S.Benedetto, G.Montorsi, D.Divsalar, F.Pollara, 'Serial Concatenation of Interleaved Codes: Performance Analysis, Design, and Iterative Decoding', *TDA Progress Report 42-126*, August 15, 1996, JPL/NASA and D.Divsalar, F.Pollara, 'Serial and Hybrid Concatenated Codes with
- 30 Applications', *Proc. Inter. Symposium on Turbo Codes*, Breast, Sept.1997, pp.80-87 show that in some cases the known serially concatenated convolutional codes (SCCC) with interleavers yield superior performance to PCCC.
- 35 The problem of choosing an optimal channel coding method arises from the fact that the nature of the radio channel varies as a function of time. One decisive factor is the amount of ISI (InterSymbol Interference) in the radio channel. In the applications considered here, the transmitted radio signal consists of symbols where each symbol is a period of sinusoidal oscillation having a certain phase and

amplitude and a duration in the order of microseconds. The phase and/or amplitude of the symbol in relation to a certain reference phase and/or amplitude determines, which bit value or bit value combination the symbol refers to. An ISI channel may be modelled as a FIR (Finite Impulse Response) filter as the one in Fig. 1. The incoming (transmitted) signal on line 101 will experience an arbitrary number of delays 102, 103 and 104, where the length of each delay depends on the momentary propagation conditions of the radio wave. The weighting coefficients 105, 106, 107 and 108 are called the taps of the filter and they determine the relative importance of each delayed signal component. The summing means 109, 110 and 111 produce an outgoing (received) signal on line 112 which is the sum of the differently delayed and weighted signal components. As a result, any sequence of the received signal comprises a contribution from a number of consecutive symbols.

From the publications C. Douillard *et al*, 'Iterative Correction of Intersymbol Interference: Turbo- Equalization', *European Trans.Telecom ETT*, vol.6, No.5, pp.507-511, 1995 and A. Picart *et al*, 'Turbo-detection: A New Approach to Combat Channel Frequency Selectivity', *Proc. ICC'97*, Montreal, pp.1498-1502, 1997 it is known that the filter or other signal processing element that simulates the ISI may conceptually be regarded as a part of an inner encoder in an SCCC channel coding scheme. The corresponding channel decoding process is known as turbo-equalization. However, a FIR is a non-recursive filter and it is known that to get maximal performance the inner encoder of SCCC should be recursive. On the other hand the performance improvement provided by turbo-equalization is mainly noticeable for channels with severe ISI and much less apparent for channels with moderate or low ISI. This is in perfect agreement with the known fact that the weaker the inner code in an SCCC scheme, the less improvement is to be obtained by turbo-equalization. Even if the ISI is severe and correspondingly turbo-equalization should provide maximal gain, the non-recursivity of the ISI implies that a channel estimator in the receiver should accurately estimate the time-varying inner structure of the ISI (the time-varying taps of the filter that represents the ISI), which is not always feasible.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a channel coding and decoding scheme that would provide good performance regardless of the strength of

the ISI. It is also an object of the invention to provide a transmitter and a receiver that realize the method of the invention in practice.

5 The invention achieves the above-mentioned objects by introducing the ISI component of the radio channel with a recursive property as a part of the modulator with memory.

The method according to the invention is characterised in that it contains the successive steps of

- 10 a) encoding the digital information to be transmitted with an outer code,
- b) interleaving the encoded digital information to be transmitted,
- c) encoding the interleaved encoded digital information with a recursive inner code and in conjunction therewith modulating the encoded interleaved encoded digital information onto a carrier, and
- 15 d) transmitting the carrier containing the modulated encoded interleaved encoded digital information.

The invention applies also to a method for transferring digital information in the form of consecutive symbols from a transmitter over a transmission channel susceptible for intersymbol interference to a receiver. It is characterised in that it contains the successive steps of

- 20 a) encoding the digital information to be transmitted with an outer code,
- b) interleaving the encoded digital information to be transmitted,
- c) encoding the interleaved encoded digital information with a recursive inner code and in conjunction therewith modulating the encoded interleaved encoded digital information onto a carrier,
- 25 d) transmitting the carrier containing the modulated encoded interleaved encoded digital information,
- e) receiving the transmitted carrier containing the modulated encoded interleaved encoded digital information,
- 30 f) producing an estimate of the characteristics of the transmission channel,
- g) converting the received carrier into consecutive symbols in a SISO equalisation process using the produced estimate of the characteristics of the transmission channel,
- 35 h) deinterleaving the consecutive symbols, and
- i) decoding the deinterleaved consecutive symbols in a SISO decoding process.

The invention applies further to a transmitter, characterised in that comprises in succession

a) an outer encoder for encoding the digital information to be transmitted with an outer code,

5 b) an interleaver for interleaving the encoded digital information to be transmitted, and

c) a recursive inner encoder and a modulator for encoding the interleaved encoded digital information with a recursive inner code and in conjunction therewith modulating the encoded interleaved encoded digital information onto a carrier.

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It is possible to present an SCCC coding scheme in such a way that the inner encoder is at least partly integrated into the modulator, where it is considered as a part of a modulator with memory. According to the invention a recursive inner encoder, a memoryless modulator and an ISI channel form a combined structure that
 15 the receiver may treat as a finite state machine in the transmitting end, the Trellis path of which is possible to reconstruct by means of turbo-equalisation. An outer encoder and a pseudorandom interleaver precede the mentioned combination in the transmitter to make it an SCCC encoder. In the receiver a first decoder comprises a channel estimator to estimate the parameters of the radio channel and a Soft In -
 20 Soft Out (SISO) equalizer to remove the coding introduced by said inner encoder of the transmitting end. A deinterleaver removes the interleaving from the output of the first decoder, and a second SISO decoder removes the coding made in the outer encoder of the transmitter. A number of iterative decoding rounds in the receiver may be provided by re-interleaving the output of the second SISO decoder and
 25 feeding the result back into the SISO equalizer in the first decoder.

The invention does not place limitations to the outer encoder, so it may be for example another SCCC encoder or the known convolutional channel encoder of the GSM system. The invention is readily applicable to optimize the channel coding
 30 performance for example within the EDGE framework known to the person skilled in the art from the publication ETSI: STC SMG2, 'Enhanced Data rates for GSM Evolution (EDGE)', *Tdoc 60/98*, Geneva, Switzerland, 23-27 February, 1998.

35 BRIEF DESCRIPTION OF DRAWINGS

The novel features which are considered as characteristic of the invention are set forth in particular in the appended Claims. The invention itself, however, both as to

its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings.

- 5 Fig. 1 illustrates the presentation of an ISI channel as a FIR filter,
- Fig. 2 illustrates a system according to the invention,
- Fig. 3 presents a possible detailed structure for the encoders of Fig. 2 and
- 10 Fig. 4 present a variation of the receiving side of Fig. 2.

Fig. 1 was referred to in the description of prior art, so the following discussion of the preferred embodiments of the invention will focus primarily on Figs. 2 - 4.

15 DETAILED DESCRIPTION OF THE INVENTION

Fig. 2 illustrates a data transmission system consisting of a transmitter, a receiver and a radio channel between them. The transmitter comprises an arbitrary data source 201 which may be for example a speech codec or a video codec for converting an analogue audio and/or video signal into a stream of digital data. It is followed by the outer encoder 202 of the channel encoding scheme. The output of the outer encoder is coupled to the input of an interleaver 203 which, for the system according to the invention to provide maximal performance, must be a pseudorandom interleaver (using for example the GSM systematic diagonal interleaver mentioned in the description of prior art would not yield satisfactory performance). Pseudorandom interleavers are known as such from prior art. Their operation is based on interleaving the bits from a number of consecutive code words in a way that appears to be random but actually follows with unambiguous causality from a predetermined seed number.

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The interleaved code words are fed into a block 204 labeled as "memory". Its function in the system of Fig. 2 is to realize, together with the following memoryless modulator 205, a recursive inner code. The invention does not place specific limitations to which kind of recursive inner coding is used. Block 204 is, as mentioned, followed by a memoryless modulator 205 which maps the digital data to be transmitted into transmission symbols. With "memoryless" it is meant that on the

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contrary to the operation of block 204, block 205 does not introduce into the transmission symbols any dependency on previous transmission symbols. This is not a strict requirement in the system according to the invention, but conceptually it is easier to handle the recursivity block and the modulator block as separate units. An example of a memoryless modulator is the 8PSK (8-level Phase Shift Keying) modulator used in the EDGE (Enhanced Datarates for GSM Evolution).

The output of the memoryless modulator block 205 is the output of the transmitter device. It goes next to the intersymbol interference or ISI block 206, which is not part of a real-life transmitter but represents the processes causing intersymbol interference that take place on the radio path between the transmitter and the receiver. However, conceptually the ISI block 206 will here be regarded as operating in conjunction with blocks 204 and 205. Additive White Gaussian Noise (AWGN) is summed to the output of block 206 in the summing element 207; this is again a process that actually takes place on the radio path in a distributed fashion.

The receiver comprises a channel estimator 208, the function of which is to monitor certain parts of the received signal and to estimate on the basis of observations such characteristics of the radio channel that can be accounted for in the decoding process. If the ISI block 206 is thought to be a FIR filter like that in Fig. 1, the task of the channel estimator block 208 is to estimate the taps of the filter. The information generated in the course of channel estimation is provided to the SISO equalizer block 209 along with the received data to be decoded. Conventional SISO equalizers usually have two outputs, of which only one is used here. It is coupled to the input of a deinterleaver 210 for removing the interleaving made in block 203. The deinterleaved data is directed to a SISO decoder 211 which has also two outputs. The first output is coupled to a data sink 212 and the second output is coupled, through a re-interleaver block 213, to one of the inputs of the SISO equalizer block 209.

The operation of a coding entity in a transmitting device may be viewed as a series of state transitions in a Finite State Machine (FSM). At any given moment the coding entity must be in one of its allowed states. From each state there is a predetermined number of allowed transitions to other states. The transitions that take place are results of reading as an input the stream of data to be transmitted. It is the task of a corresponding entity in the receiving device to track down the transitions that have taken place in the transmitting device and to reconstruct the stream of data that must have caused the observed sequence of state transitions. To

accomplish this task the entity in the receiving device uses the received stream of data as an input and applies its knowledge about which transitions are allowed and what seems to be the probability that certain sequence of transitions have occurred. This process is known as finding the correct Trellis path through the sets of allowed states. In iterative decoding the receiver runs a decoding algorithm several times on same data and uses the result(s) from the previous round(s) to refine its judgement on those transitions that are not completely clear.

In the system of Fig. 1, the first FSM in the transmitter is the outer encoder 202, designated also as FSM1. The second FSM or FSM2 consists of the recursive inner encoder block 204 and the memoryless modulator block 205. The third FSM or FSM3 is the ISI channel representation 206 and the fourth FSM or FSM4 is a combination of the second FSM and the third FSM. In the receiver the SISO decoder 211 tries to track down the state transitions that have taken place in the outer encoder 202. For doing this it uses its preprogrammed knowledge about the allowed transitions; the preprogrammed knowledge appears in Fig. 2 as the oval block labeled (FSM1). Similarly the SISO equalizer 209 retrieves the operation of the entity formed by the memory block 204 and the memoryless modulator 205, by using the preprogrammed knowledge represented by (FSM2).

The channel estimator 208 is the receiver's counterpart for the ISI block 206, but it can not have any preprogrammed knowledge about the operation of block 206 because the ISI block is not a causally operating part of any real-life device but only a conceptual representation of the phenomena that take place on the radio path between the transmitter and the receiver. To accomplish its task the channel estimator monitors a certain part of the received signal. Said certain part is typically a "training sequence" or other interval in each transmission burst that repeats itself in a known form. The channel estimator monitors the received signal during the training sequence and generates an estimate about what kind of channel conditions could have caused the observed deviations from the predetermined form of the signal. Channel estimation of this kind is known as such to the person skilled in the art. The SISO equalizer 209 receives the generated estimate, designated as (FSM3), as input information from the channel estimator 208 parallelly with the actual received signal.

Let us assume that the system of Fig. 2 operates under conditions where ISI is severe. As stated above in the description of prior art, the iterative turbo-equalisation performed by the receiver structure of Fig. 2 is correspondingly at its

best in providing gain in comparison with other decoding schemes. Further, the recursivity added in block 204 aids in effectively performing the decoding. The channel estimator 208 delivers the estimated channel parameters to the SISO equalizer 209, which in this case works over the combined Trellis of the combined entity FSM4 on the conceptually viewed transmitting side.

Next we may assume that ISI is moderate or weak. On the conceptually viewed transmitting side, this corresponds to block 206 being nonexistent or at least not very significant in terms of introduced channel coding in relation to the other blocks. In the receiver, channel estimation is rather straightforward, so also the functional significance of block 208 is rather limited. In that case the channel coding scheme resembles an SCCC channel coding solution, which is known to outperform PCCC or turbo codes under weak ISI conditions.

In order to keep the complexity low both in the transmitter and in the receiver, the inner code used in block 204 may be a very simple recursive code. For example, a differential encoder may be used as an inner encoder. Fig. 3 illustrates an exemplary construction for blocks 202 and 204. The outer encoder consists of two delay elements 301 and 302 together with three summing elements 303, 304 and 305 and a multiplexer 306. Puncturing 307 may be performed between the outer encoder 202 and the interleaver 203, but this is not necessary if the available data rates otherwise meet the output rate of the encoding scheme. The simple inner encoder 204 of Fig. 3 consists of only one delay element 308 and a summing element 309. A simple way to implement a more complex inner code is to add delay elements one after each other in block 204 and to combine the outputs of the delay elements in some preferred way. A more elaborate way of integrating a recursive inner encoder and a modulator would be to use some Trellis Coded Modulator (TCM) like a Parallel Concatenated Trellis Coded Modulator or a Serial Concatenated Trellis Coded Modulator known as such from for example the publication D.Divsalar, F.Pollara, 'Serial and Hybrid Concatenated Codes with Applications', *Proc. Inter. Symposium on Turbo Codes*, Breast, Sept.1997, pp.80-87.

Fig. 4 illustrates an iterative decoder that can be used if the encoder is the one in Fig. 3. The only difference to the structure of Fig. 2 is the use of a depuncturing block 401 and a repuncturing block 402 which are needed if block 307 is present in the transmitting end. Naturally block 209 must be constructed so that the decoding operation it performs conforms to the code used in block 204, and equally the decoding function of block 211 must correspond to the code introduced by block

202. Presenting a corresponding decoding structure for a known encoder is as such known to the person skilled in the art.

Simulation results for the rather simple structures of Figs. 3 and 4 show that if the size of a data sequence to be interleaved is the same as a GSM data frame and the channel has AWGN properties, after 4 iterations the SCCC scheme outperforms the the 1/2-rate convolutional code (CC) used in GSM at BER (Bit Error Ratio) $<10^{-3}$ and provides a gain of 1.5 dB at BER = 10^{-6} . An additional gain of 1 dB may be obtained by using a MAP (Maximum A posteriori Probability) algorithm in the SISO blocks instead of the more common max-log-MAP algorithm and increasing the number of iterations. Even more gain may be obtained if the GSM convolutional code is used as the outer code.

A significant advantage of the system according to the invention is that it allows for building different kinds of receivers in terms of complexity and performance. A simple receiver might have the capacity to perform only a limited number of iterations during each decoding cycle. A more expensive "high-end" receiver might have a faster processor and faster other signal processing circuits and correspondingly the capacity of performing more iterations during each decoding cycle. By increasing the number of iterations the number of decoding errors can be reduced, although at some stage (usually around some tens of iterations) the receiver performance will start approaching a theoretical limit.

CLAIMS

1. A method for transmitting digital information in the form of consecutive symbols over a transmission channel susceptible for intersymbol interference, comprising, in the following order, the successive steps of
 - 5 a) encoding the digital information to be transmitted with an outer code,
 - b) interleaving the encoded digital information to be transmitted,
 - c) encoding the interleaved encoded digital information with a recursive inner code and in conjunction therewith modulating the encoded interleaved encoded digital information onto a carrier, and
 - 10 d) transmitting the carrier containing the modulated encoded interleaved encoded digital information.
2. A method according to claim 1, wherein step b) consists of pseudorandom interleaving.
- 15 3. A method according to claim 1, wherein the recursive inner code in step c) is a differential code.
4. A method according to claim 3, wherein step c) consists of modulating the interleaved encoded digital information onto a carrier using a differential modulation method.
- 20 5. A method according to claim 1, wherein the outer code in step a) is a convolutional code.
- 25 6. A method according to claim 5, wherein the outer code in step a) is a serial concatenated convolutional code.
7. A method for transferring digital information in the form of consecutive symbols from a transmitter over a transmission channel susceptible for intersymbol interference to a receiver, comprising, in the following order, the successive steps of
 - 30 a) encoding the digital information to be transmitted with an outer code,
 - b) interleaving the encoded digital information to be transmitted,
 - c) encoding the interleaved encoded digital information with a recursive inner code and in conjunction therewith modulating the encoded interleaved encoded digital information onto a carrier,
 - 35 d) transmitting the carrier containing the modulated encoded interleaved encoded digital information,

- e) receiving the transmitted carrier containing the modulated encoded interleaved encoded digital information,
 - f) producing an estimate of the characteristics of the transmission channel,
 - g) converting the received carrier into consecutive symbols in a SISO equalisation process using the produced estimate of the characteristics of the transmission channel,
 - h) deinterleaving the consecutive symbols, and
 - i) decoding the deinterleaved consecutive symbols in a SISO decoding process.
8. A method according to claim 7, additionally comprising a number of iterations through steps g), h) and i) as well as a step of reinterleaving between steps i) and g), wherein said number is at least 2.
9. A method according to claim 7, wherein the SISO equalisation process of step g) works over the combined Trellis of the recursive inner code and modulation of step c) and the nonrecursive intersymbol interference characteristics of the transmission channel.
10. A transmitter for transmitting digital information in the form of consecutive symbols over a transmission channel, comprising
- a) an outer encoder for encoding the digital information to be transmitted with an outer code, said outer encoder having an input and an output,
 - b) an interleaver for interleaving the encoded digital information to be transmitted, said interleaver having an input and an output of which the input is coupled to the output of the outer encoder and
 - c) a recursive inner encoder and a modulator unit for encoding the interleaved encoded digital information with a recursive inner code and in conjunction therewith modulating the encoded interleaved encoded digital information onto a carrier, said recursive inner encoder and a modulator unit having an input and an output of which the input is coupled to the output of the interleaver.
11. A transmitter according to claim 10, wherein said interleaver is a pseudorandom interleaver.
12. A transmitter according to claim 10, wherein said recursive inner encoder and modulator unit forms an integrated structure.

13. A transmitter according to claim 12, wherein said integrated structure is a differential modulator.

14. A transmitter according to claim 12, wherein said integrated structure is a
5 Trellis Coded Modulator.

11/11/11 11:11:11

ABSTRACT

For transferring digital information in the form of consecutive symbols from a transmitter over a transmission channel susceptible for intersymbol interference to a receiver, the following steps are taken in succession:

- a) encoding the digital information to be transmitted with an outer code (202),
- b) interleaving the encoded digital information to be transmitted (203),
- c) encoding the interleaved encoded digital information with a recursive inner code (204) and in conjunction therewith modulating the encoded interleaved encoded digital information onto a carrier (205),
- d) transmitting the carrier containing the modulated encoded interleaved encoded digital information,
- e) receiving the transmitted carrier containing the modulated encoded interleaved encoded digital information,
- f) producing an estimate of the characteristics of the transmission channel (208),
- g) converting the received carrier into consecutive symbols in a SISO equalisation process using the produced estimate of the characteristics of the transmission channel (209),
- h) deinterleaving the consecutive symbols (210), and
- i) decoding the deinterleaved consecutive symbols in a SISO decoding process (211).

Fig. 2

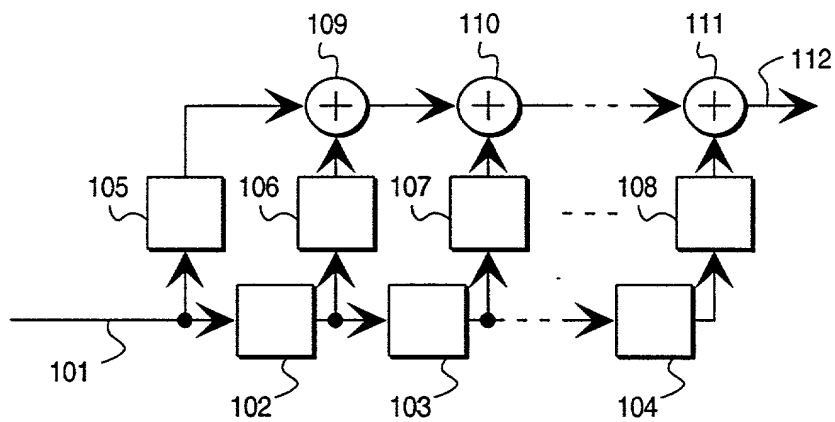


Fig. 1

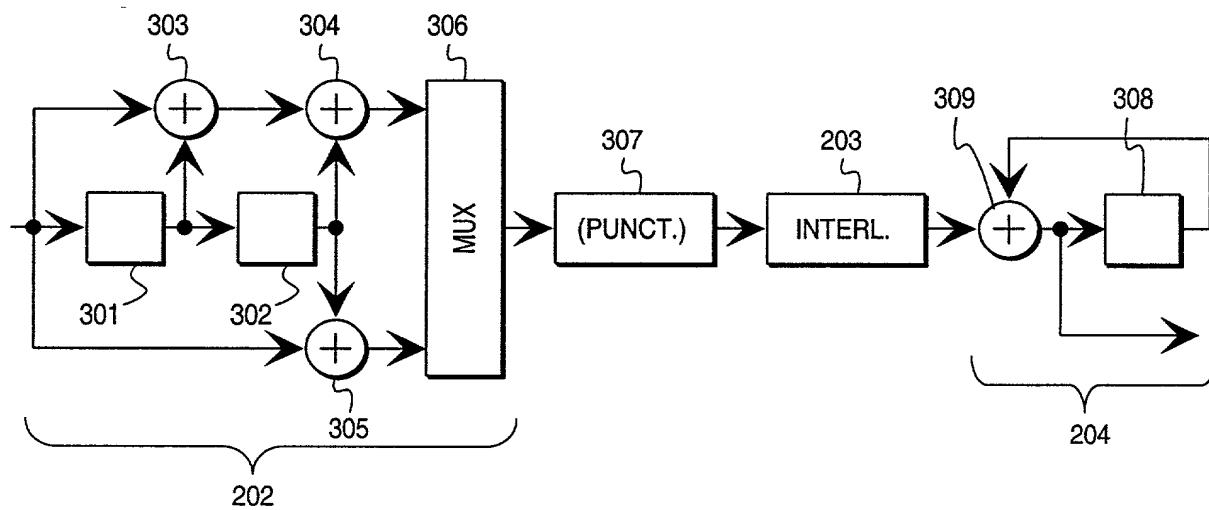


Fig. 3

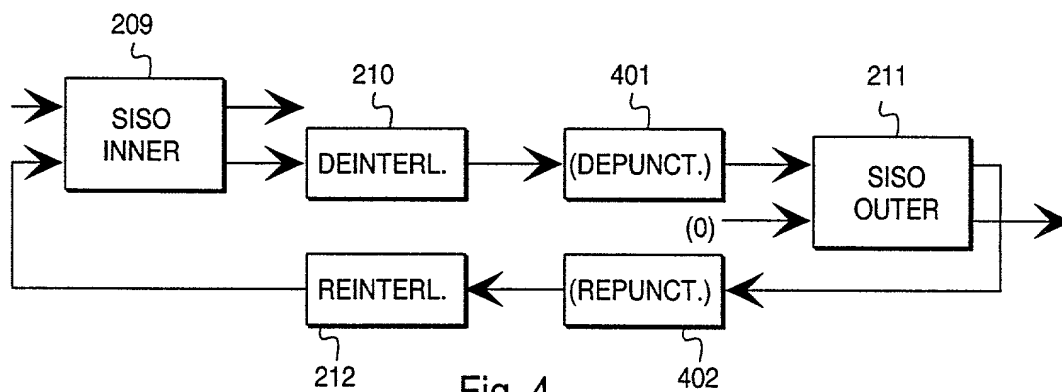


Fig. 4

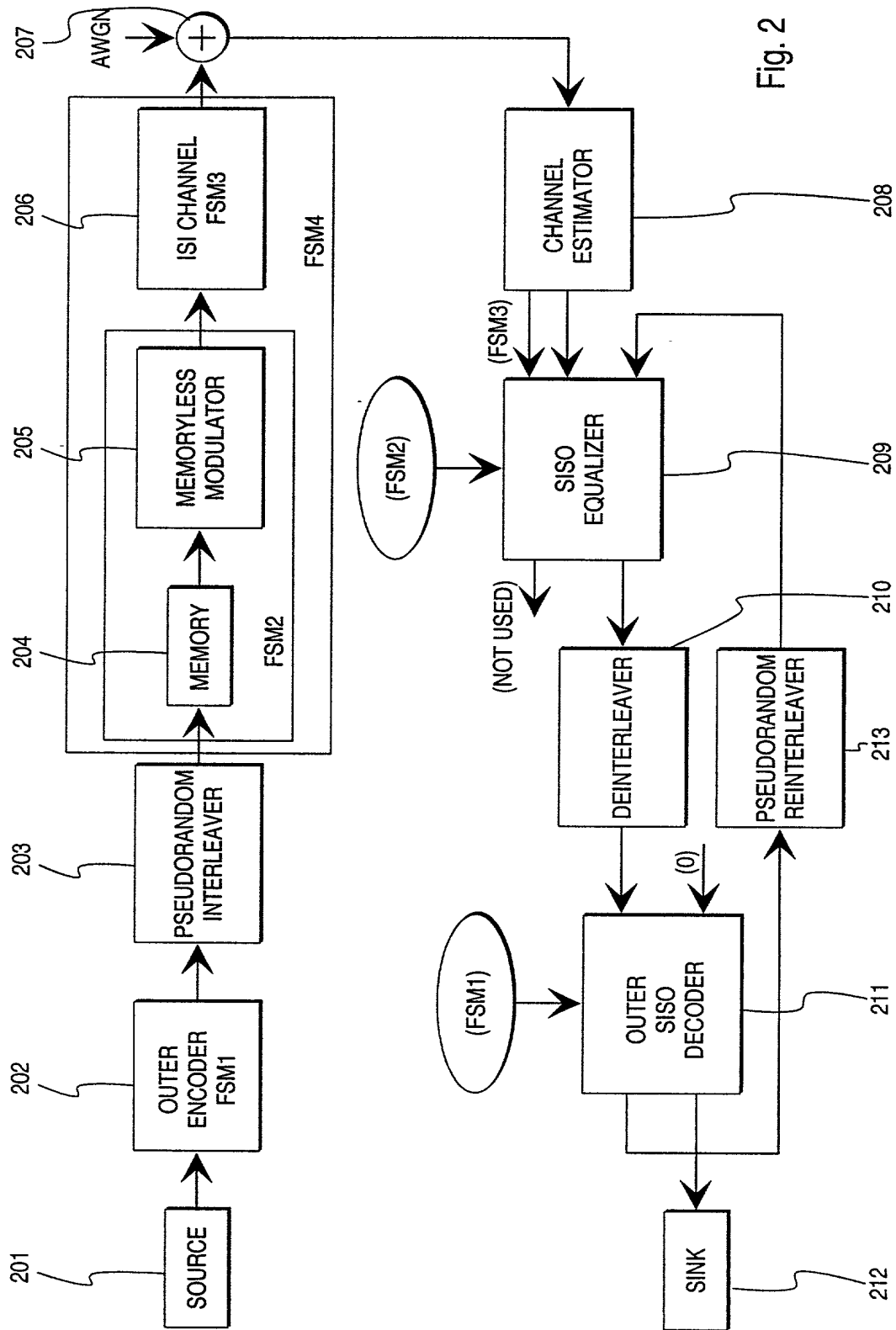


Fig. 2

**COMBINED DECLARATION AND POWER OF ATTORNEY
(ORIGINAL, DESIGN, NATIONAL STAGE OF PCT, SUPPLEMENTAL, DIVISIONAL,
CONTINUATION OR C-I-P)**

As a below named inventor, I hereby declare that:

TYPE OF DECLARATION

This declaration is of the following type:

(check one applicable item below)

☒ original.

☐ design.

☐ supplemental.

NOTE. If the declaration is for an International Application being filed as a divisional, continuation or continuation-in-part application, do not check next item; check appropriate one of last three items.

☐ national stage of PCT.

NOTE: If one of the following 3 items apply, then complete and also attach ADDED PAGES FOR DIVISIONAL, CONTINUATION OR C-I-P.

☐ divisional.

☐ continuation.

☐ continuation-in-part (C-I-P).

INVENTORSHIP IDENTIFICATION

WARNING: If the inventors are each not the inventors of all the claims, an explanation of the facts, including the ownership of all the claims at the time the last claimed invention was made, should be submitted.

My residence, post office address and citizenship are as stated below, next to my name. I believe that I am the original, first and sole inventor (*if only one name is listed below*) or an original, first and joint inventor (*if plural names are listed below*) of the subject matter that is claimed, and for which a patent is sought on the invention entitled:

TITLE OF INVENTION

Method and apparatus for channel coding and decoding for modulation
schemes with memory

SPECIFICATION IDENTIFICATION

the specification of which:

(complete (a), (b) or (c))

- (a) ☒ is attached hereto.
(b) ☐ was filed on _____, as ☐ Serial No. _____
or ☐ Express Mail No., as Serial No. not yet known _____
and was amended on _____ *(if applicable)*.

NOTE. Amendments filed after the original papers are deposited with the PTO that contain new matter are not accorded a filing date by being referred to in the declaration. Accordingly, the amendments involved are those filed with the application papers or, in the case of a supplemental declaration, are those amendments claiming matter not encompassed in the original statement of invention or claims. See 37 CFR 1.67.

- (c) ☐ was described and claimed in PCT International Application No. _____,
filed on _____ and as amended under PCT Article 19 on
_____ *(if any)*.

ACKNOWLEDGEMENT OF REVIEW OF PAPERS AND DUTY OF CANDOR

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information, which is material to patentability as defined in 37, Code of Federal Regulations, § 1.56,

(also check the following items, if desired)

☒ and which is material to the examination of this application, namely, information where there is a substantial likelihood that a reasonable Examiner would consider it important in deciding whether to allow the application to issue as a patent, and

☒ in compliance with this duty, there is attached an information disclosure statement, in accordance with 37 CFR 1.98.

PRIORITY CLAIM (35 U.S.C. § 119(a)-(d))

I hereby claim foreign priority benefits under Title 35, United States Code, § 119(a)-(d) of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed.

(complete (d) or (e))

- (d) ☐ no such applications have been filed.
(e) ☒ such applications have been filed as follows.

NOTE. Where item (c) is entered above and the International Application which designated the U.S. itself claimed priority check item (e), enter the details below and make the priority claim.

**PRIOR FOREIGN/PCT APPLICATION(S) FILED WITHIN 12 MONTHS
(6 MONTHS FOR DESIGN) PRIOR TO THIS APPLICATION
AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. § 119(a)-(d)**

COUNTRY(OR INDICATE IF PCT)	APPLICATION NUMBER	DATE OF FILING (day, month, year)	PRIORITY CLAIMED UNDER 37 USC 119	
FINLAND	981745	12 August 1998	<input checked="" type="checkbox"/> YES	NO <input type="checkbox"/>
			<input type="checkbox"/> YES	NO <input type="checkbox"/>
			<input type="checkbox"/> YES	NO <input type="checkbox"/>
			<input type="checkbox"/> YES	NO <input type="checkbox"/>
			<input type="checkbox"/> YES	NO <input type="checkbox"/>

**CLAIM FOR BENEFIT OF PRIOR U.S. PROVISIONAL APPLICATION(S)
(34 U.S.C. § 119(e))**

I hereby claim the benefit under Title 35, United States Code, § 119(e) of any United States provisional application(s) listed below:

PROVISIONAL APPLICATION NUMBER

FILING DATE

_____/_____
_____/_____
_____/_____

**CLAIM FOR BENEFIT OF EARLIER US/PCT APPLICATION(S)
UNDER 35 U.S.C. 120**

___ The claim for the benefit of any such applications are set forth in the attached
ADDED PAGES TO COMBINED DECLARATION AND POWER OF
ATTORNEY FOR DIVISIONAL, CONTINUATION OR CONTINUATION-IN
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NOTE. If the application filed more than 12 months from the filing date of this application is a PCT filing forming the basis for this application entering the United States as (1) the national stage, or (2) a continuation, divisional, or continuation-in-part, then also complete ADDED PAGES TO COMBINED DECLARATION AND POWER OF ATTORNEY FOR DIVISIONAL, CONTINUATION OR C-I-P APPLICATION for benefit of the prior U.S. or PCT application(s) under 35 U.S.C. § 120.

POWER OF ATTORNEY

I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.

(list name and registration number)

Clarence A. Green	(24,622)
Harry F. Smith	(32,493)
Mark F. Harrington	(31,686)

(check the following item, if applicable)

☐ Attached, as part of this declaration and power of attorney, is the authorization of the above-named attorney(s) to accept and follow instructions from my representative(s).

SEND CORRESPONDENCE TO

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Perman & Green
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Fairfield, Ct 06430

DIRECT TELEPHONE CALLS TO:
(Name and telephone number)

Clarence A. Green
203-259-1800

DECLARATION

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that wilful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such wilful false statements may jeopardize the validity of the application or any patent issued thereon.

SIGNATURE(S)

NOTE: Carefully indicate the family (or last) name, as it should appear on the filing receipt and all other documents.

Full name of sole or first inventor:

Given name: Nikolai
Middle initial or name:
Family (or last name): NEFEDOV

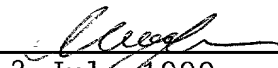
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Given name:
Middle initial or name:
Family (or last name):

Inventor's signature:

Date:

Country of Citizenship:

Residence:

Post Office Address:

Full name of fourth joint inventor, if any:

Given name:
Middle initial or name:
Family (or last name):

Inventor's signature:

Date:

Country of Citizenship:

Residence:

Post Office Address:

(check proper box(es) for any of the following added page(s)
that form a part of this declaration)

___ **Signature** for fifth and subsequent joint inventors. *Number of pages added* _____.

* * *

___ **Signature** by administrator(trix), executor(trix) or legal representative for deceased or incapacitated inventor. *Number of pages added* _____.

* * *

___ **Signature** for inventor who refuses to sign or cannot be reached by person authorized under 37 CFR 1.47. *Number of pages added* _____.

* * *

___ Added page for **signature** by one joint inventor on behalf of deceased inventor(s) where legal representative cannot be appointed in time. (37 CFR 1.47)

* * *

___ Added pages to combined declaration and power of attorney for divisional, continuation, or continuation-in-part (C-I-P) application.

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* * *

___ Authorization of attorney(s) to accept and follow instructions from representative.

* * *

(if no further pages form a part of this Declaration,
then end this Declaration with this page and check the following item)

___ ☒ This declaration ends with this page.